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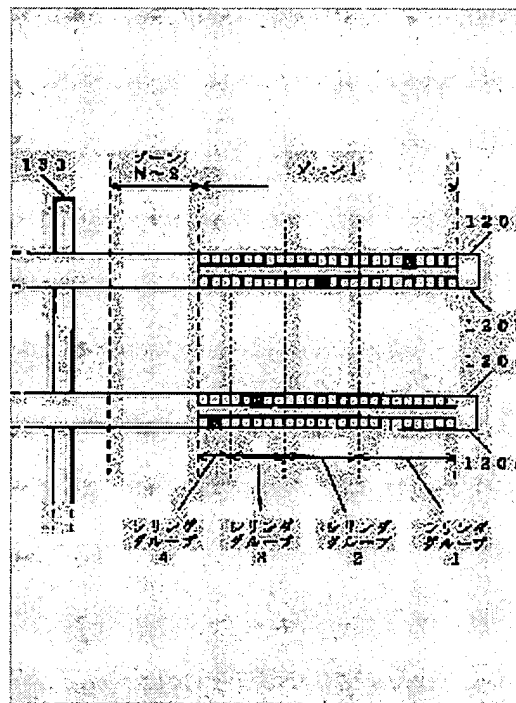
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## (54) DISK DEVICE AND REASSIGNING METHOD

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To solve a problem that a spare area is densely arranged to suppress increase of response delay time after a reassignment processing, however, on the other hand, use efficiency of a disk is lowered when the spare area is densely arranged, with respect to a disk device to perform the reassignment processing when an unrecoverable defect is generated on a recording surface of the disk.

**SOLUTION:** The recording surface of plural disks are divided into plural cylinder groups consisting of plural cylinders respectively and spare tracks are assigned to each of the divided cylinder groups in by one. When the spare track are assigned in this way, head seek quantity to be required for accessing the spare area is reduced by accessing the spare area on other recording surface from a defective sector by using switching of heads and the spare area is accessed in shorter time. Thus, increase of the response delay time to the access to an alternative sector is reduced, consequently, capacity of the spare track is reduced and the use efficiency of the disk is enhanced.



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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] More specifically, this invention relates to the disk unit and the rear sign approach of performing rear sign processing to an unrecoverable defective sector about a disk unit and the rear sign approach.

[0002]

[Description of the Prior Art] Generally the sector which is the minimum field for storing data exists in the recording surface of a disk. And the truck which made the group all the sectors that exist in the equal distance from the core of disk rotation is formed. Furthermore, it is in two or more recording surfaces, and the cylinder which made the group the truck which exists in the equal distance from a rotational core is formed.

[0003] the recording surface of the prepared disk resembles a disk unit, respectively, it is received, and the head which performs record or playback of data is prepared in it. When access a certain sector and performing record or playback of data, the head which is performing record or playback of current data changes to the head corresponding to the recording surface in which the sector of that request exists (this actuation calls the change of a head hereafter), and it makes move to coincidence so that it may be located on the truck which exists in the sector that changed head of whose is a request (this actuation calls head seeking hereafter). Then, when a desired sector arrives at the location of a head by rotation of a disk, record or playback of data is performed.

[0004] Head seeking is needed in existing on a cylinder which is different from the sector which the change of a head is needed and is carrying out current access when the sector which should be accessed exists on a different recording surface from the sector which is carrying out current access, in order that a disk unit may perform record or playback of data by the above actuation. The change of a head takes the time amount for hundreds of microseconds, and head seeking takes the time amount beyond about tens or it by the case of the migration from a truck on the truck of the most inner circumference of the outermost periphery of a disk. Therefore, the change of a head and activation of head seeking bring about the increment in the answering delay time amount of a disk unit. Therefore, without needing a change and head seeking of a head, record of continuous data is usually recorded on the sector which followed the circumferencial direction on the same truck so that record or playback of data can be performed.

[0005] On the other hand, in the above-mentioned disk unit, in case record or playback of data is performed, an unrecoverable error may arise in a specific sector. When such an error arises, there is rear sign processing as an approach that record or playback of data can be performed, without reformatting. Rear sign processing is processing which assigns the sector in the field of the reserve called the spare field currently beforehand assigned to the recording surface of a disk to the defective sector which the unrecoverable error produced as an alternate sector.

[0006] After rear sign processing, when the processing which performs record or playback of data to the above-mentioned defective sector occurs, access to the alternate sector assigned by rear sign processing

is performed to whenever [ the ], and record or playback of data is performed to it. That is, when an alternate sector is assigned by rear sign processing on a different recording surface from a defective sector thru/or a different cylinder, whenever the processing to a defective sector occurs, a change thru/or head seeking of a head will be performed after rear sign processing, respectively. As mentioned above, since the change of these heads and activation of head seeking lead to the increment in the answering delay time amount of a disk unit, in rear sign processing, it is desirable to arrange an alternate sector so that the increment in this answering delay time amount may decrease as much as possible. It is desirable to suppress the increment in answering delay time amount to the time amount for 1 of a disk rotation, since the increment in the answering delay time amount equivalent to a part for disk until sector which follows defective sector as the access time of which is short when record [ of the data to the sector which follows a defective sector again after accessing an alternate sector especially ], or regeneration is performed reaches head part again 1 rotation is not avoided.

[0007] As a cure to the above-mentioned request, there were three approaches described below conventionally. The 1st approach is an approach currently indicated by JP,8-45190,A, and is the approach of assigning 1 of two or more disk recording surfaces thru/or two or more whole recording surfaces as a spare field for arranging an alternate sector at the time of rear sign processing. According to this 1st approach, since a spare field can be accessed only by the change of a head from the defective sector of arbitration, it is possible to arrange an alternate sector from a defective sector in the location which can be accessed only by the time amount which the change of a head takes. Therefore, it is possible to suppress the increment in the answering delay time amount after rear sign processing.

[0008] The 2nd and 3rd approaches divide the recording surface of a disk into radial in two or more zones, and form a spare track for every zone. When the recording surface of a disk is divided into radial in two or more zones and a more nearly outside zone generally carries out record or playback of data to radial with a high clock frequency, the track recording density of a disk recording surface can be improved, and the storage capacity of an entire disk can be improved. Such a record approach is called zone bit recording (ZBR is called hereafter). The 2nd and 3rd approaches are configuration methods of the spare field in the disk which adopted such [ mainly ] ZBR, and an alternate sector.

[0009] The 2nd approach is an approach currently indicated by JP,6-96525,A, and drawing 8 is the conceptual diagram of a disk cross section to show the arrangement location of the spare field by this conventional approach. As shown in drawing, it is the approach of the zone (in drawing, inside [ it is two or more zones ] shows only the outside zone 1 especially to the detail most) divided into plurality of breaking an inside track as a spare track most, respectively, and hitting. According to this 2nd approach, since head seeking to an alternate sector serves as migration from the outermost periphery in one zone to the most inner circumference at the maximum, it can shorten the head seek time compared with the case where it does not divide into a zone. Moreover, generally, in each zone, the area per 1 sector is as small as an inside track, and it becomes easy to generate an error. Therefore, the increment in overall answering delay time amount is suppressed more by establishing a spare track in the most inner circumference of a zone which a defective sector tends to produce.

[0010] In each of the zone which the 3rd approach is an approach currently indicated by JP,10-134516,A, and was divided into plurality A spare field is assigned to the location which can access and can return from the sector of the arbitration in a zone by the time amount equivalent to disk 1 rotation. Further at the time of a rear sign It is the approach of arranging an alternate sector in the location distant from the defective sector in a spare field more than the predetermined include angle (include angle which a disk rotates in the meantime in the inside in the case of accessing the spare field of arbitration from the track of the arbitration on the same zone when taking time amount most). According to this 3rd approach, time amount after accessing an alternate sector until it returns can be suppressed below to the time amount equivalent to disk 1 rotation.

[0011]

[Problem(s) to be Solved by the Invention] However, by the 1st approach of the above, in order to use the 1st page of the whole of a disk recording surface as a spare field at least, the rate of the capacity of the spare field occupied in the capacity of the whole disk unit became large, and there was a problem

that the use effectiveness of a disk will fall. Moreover, by the 2nd approach of the above, since the remarkable head seek time is needed when a defective sector arises in the outermost periphery of a zone, in order to suppress the increment in the answering delay time amount of a disk unit by the time amount of disk 1 rotation, width of face of a zone needed to be made small and spacing of a spare truck needed to be made dense. Then, the rate of a spare field became large also in this case, and there was a problem that the use effectiveness of a disk will fall. Moreover, although the increment in the answering delay time amount of a disk unit is suppressed to the time amount of disk 1 rotation by the 3rd approach of the above. Also in this case, since it mainly opts for assignment of a spare sector and an alternative field based on the access time to the alternate sector by head seeking. As a result, like the 2nd approach, the rate of a spare field became large and there was a problem that the use effectiveness of a disk will fall. [0012] So, the purpose of this invention is offering the disk unit which suppressed the increment in the answering delay time amount by access to the alternate sector after a rear sign, reducing the rate of the spare field for rear sign processing occupied to the whole disk unit.

[0013]

[The means for solving a technical problem and an effect of the invention] A disk-like record means for the 1st invention to be a disk unit which performs rear sign processing to an unrecoverable defective sector, and to have two or more recording surfaces as the whole including the disk-like record medium of one or more sheets, The disk driving means which rotates a disk-like record medium, and two or more heads which are prepared corresponding to each of two or more recording surfaces, and perform record or playback of data to a corresponding recording surface, It has a spare field arrangement means to arrange the head control means which controls two or more heads, and the spare field for arranging the alternate sector to a defective sector in rear sign processing in a mutually different location on two or more recording surfaces.

[0014] As mentioned above, since the spare field for arranging an alternate sector is arranged in the location where two or more recording surfaces differ mutually, respectively according to the 1st invention, access to an alternate sector becomes more possible in a short time by using the change of a head. Therefore, it is possible to suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing. Moreover, the capacity of the part spare field can be reduced and it is possible to raise the use effectiveness of a disk.

[0015] 2nd invention is characterized by for a spare field arrangement means shifting a spare field mutually to radial [ of a disk-like record medium ], and arranging it to it to each of two or more recording surfaces, in the 1st invention.

[0016] As mentioned above, according to the 2nd invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively by shifting and arranging a spare field to radial for every recording surface.

[0017] The 3rd invention is set to the 2nd invention. To each of two or more recording surfaces In each recording surface, two or more sectors which exist in the equal distance from a rotational core by storing data per sector In each recording surface, two or more trucks which exist in the equal distance from a rotational core by each gathering and forming one truck Each gathers, one cylinder is formed and a spare field arrangement means is characterized by arranging the spare truck which makes all the fields of a truck a spare field on the truck on a different cylinder for every recording surface.

[0018] As mentioned above, since the spare truck for arranging an alternate sector is arranged in a different cylinder for every recording surface according to the 3rd invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0019] Two or more cylinders as which the 4th invention is specified in each recording surface in the 3rd invention are classified into two or more cylinder groups, and the cylinder by which a spare truck is arranged to each recording surface is characterized by belonging to a cylinder group mutually different, respectively.

[0020] As mentioned above, since one spare truck for arranging an alternate sector is arranged for every cylinder group according to the 4th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively. Furthermore, it is possible by setting up a

cylinder group's magnitude according to an individual at arbitration to change the consistency of a spare field easily.

[0021] 5th invention is characterized by for a spare field arrangement means shifting a spare field mutually to the hand of cut of a disk-like record medium, and arranging it to it to each of two or more recording surfaces, in the 1st invention.

[0022] As mentioned above, according to the 5th invention, since a spare field is shifted and arranged to a hand of cut for every recording surface, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0023] In the 5th invention, as for the 6th invention, data are stored per sector at each of two or more recording surfaces, and a spare field arrangement means is characterized by arranging a spare field into the sector of include-angle range which is different for every recording surface from a rotational core.

[0024] As mentioned above, since a spare field is arranged into the sector of different include-angle range for every recording surface according to the 6th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0025] In the 6th invention, the include-angle range where, as for the 7th invention, a spare field is arranged for every recording surface is characterized by being [ every ] separated more than the predetermined include angle for every recording surface.

[0026] As mentioned above, since a spare field is arranged into the sector of different include-angle range for every recording surface according to the 7th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0027] 8th invention is characterized by a predetermined include angle being an include angle which a disk-like record medium rotates to the time amount which the change of a head takes in the 7th invention.

[0028] As mentioned above, since it arranges into the sector of the include-angle range distant more than the include angle to which a disk rotates a spare field for every recording surface to the time amount which the change of a head takes according to the 8th invention, it can access from the spare field on the recording surface of arbitration to the spare field on other recording surfaces in a short time using the change of a head. Therefore, only in the spare field on a certain truck, when performing rear sign processing to two or more continuous defective sectors, also when all alternate sectors cannot be arranged, it is possible to arrange the remaining alternate sector to the spare field of other recording surfaces which can be accessed in a short time using the change of a head. Therefore, it is possible to suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing. Moreover, the capacity of the part spare field can be reduced and it is possible to raise the use effectiveness of a disk.

[0029] The 9th invention is further equipped with an alternate-sector arrangement means to be able to access by the shortest time amount from a defective sector, and to arrange the alternate sector to a defective sector to an usable spare field, in the 1st to 8th one of invention.

[0030] As mentioned above, according to the 9th invention, since it is arranged to the usable spare field which can be accessed by the shortest time amount from a defective sector, the alternate sector to a defective sector can suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing.

[0031] Including the disk-like record medium of one or more sheets, in a disk unit equipped with a disk-like record means to have two or more recording surfaces as the whole, the 10th invention is the rear sign approach which arranges the alternate sector to an unrecoverable defective sector to a spare field, and contains the step which arranges a spare field in a mutually different location on two or more recording surfaces, and the step which arranges an alternate sector to a spare field.

[0032] As mentioned above, since the spare field for arranging an alternate sector is arranged in the location where two or more recording surfaces differ mutually, respectively according to the 10th invention, access to an alternate sector becomes more possible in a short time by using the change of a head. Therefore, it is possible to suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing. Moreover, the capacity of the part spare field can be

reduced and it is possible to raise the use effectiveness of a disk.

[0033] The step to which the 11th invention arranges a spare field in the 10th invention is characterized by shifting a spare field mutually to radial [ of a disk-like record medium ], and arranging it to it to each of two or more recording surfaces.

[0034] As mentioned above, according to the 11th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively by shifting and arranging a spare field to radial for every recording surface.

[0035] The 12th invention is set to the 11th invention. To each of two or more recording surfaces In each recording surface, two or more sectors which exist in the equal distance from a rotational core by storing data per sector In each recording surface, two or more trucks which exist in the equal distance from a rotational core by each gathering and forming one truck The step which each gathers, forms one cylinder and arranges a spare field is characterized by arranging the spare truck which makes all the fields of a truck a spare field on the truck on a different cylinder for every recording surface.

[0036] As mentioned above, since the spare truck for arranging an alternate sector is arranged in a different cylinder for every recording surface according to the 12th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0037] The cylinder by which a spare truck is arranged to each recording surface, including further the step which classifies into two or more cylinder groups two or more cylinders specified [ in / on the 12th invention and / in the 13th invention / each recording surface ] is characterized by belonging to a cylinder group mutually different, respectively.

[0038] As mentioned above, since one spare truck for arranging an alternate sector is arranged for every cylinder group according to the 13th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively. Furthermore, it is possible by setting up a cylinder group's magnitude according to an individual at arbitration to change the consistency of a spare field easily.

[0039] The step to which the 14th invention arranges a spare field in the 10th invention is characterized by shifting a spare field mutually to the hand of cut of a disk-like record medium, and arranging it to it to each of two or more recording surfaces.

[0040] As mentioned above, according to the 14th invention, since a spare field is shifted and arranged to a hand of cut for every recording surface, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0041] A means by which data are stored in each of two or more recording surfaces per sector in the 14th invention, and the 15th invention arranges a spare field is characterized by arranging a spare field into the sector of include-angle range which is different for every recording surface from a rotational core.

[0042] As mentioned above, since a spare field is arranged into the sector of different include-angle range for every recording surface according to the 15th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0043] In the 15th invention, the include-angle range where, as for the 16th invention, a spare field is arranged for every recording surface is characterized by being [ every ] separated more than the predetermined include angle for every recording surface.

[0044] As mentioned above, since a spare field is arranged into the sector of different include-angle range for every recording surface according to the 16th invention, a spare field can be easily arranged in the location where two or more recording surfaces differ mutually, respectively.

[0045] 17th invention is characterized by a predetermined include angle being an include angle which a disk-like record medium rotates in a disk unit to the time amount which the change of a head takes in the 16th invention.

[0046] As mentioned above, since it arranges into the sector of the include-angle range distant more than the include angle to which a disk rotates a spare field for every recording surface to the time amount which the change of a head takes according to the 17th invention, it can access from the spare field on the recording surface of arbitration to the spare field on other recording surfaces in a short time using the

change of a head. Therefore, only in the spare field on a certain truck, when performing rear sign processing to two or more continuous defective sectors, also when all alternate sectors cannot be arranged, it is possible to arrange the remaining alternate sector to the spare field of other recording surfaces which can be accessed in a short time using the change of a head. Therefore, it is possible to suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing. Moreover, the capacity of the part spare field can be reduced and it is possible to raise the use effectiveness of a disk.

[0047] The step to which the 18th invention arranges an alternate sector in the 10th to 17th one of invention is characterized by being able to access by the shortest time amount from a defective sector, and arranging the alternate sector to a defective sector to said usable spare field.

[0048] As mentioned above, according to the 18th invention, since it is arranged to the usable spare field which can be accessed by the shortest time amount from a defective sector, the alternate sector to a defective sector can suppress the increment in the answering delay time amount by access to the alternate sector after rear sign processing.

[0049]

[Embodiment of the Invention] (1st operation gestalt) Drawing 1 is the block diagram showing the configuration of the disk unit concerning the 1st operation gestalt of this invention. This disk unit is equipped with Disks 110a and 110b, the disk revolving shaft 130, a motor 140, Heads 150a, 150b, 150c, and 150d, the actuator arm 160, the voice coil motor (VCM is called hereafter) 170, and the hard disk controller (HDC is called hereafter) 180 in drawing 1. Disk 110a has recording surfaces 120a and 120b, and disk 110b has recording surfaces 120c and 120d.

[0050] Hereafter, the actuation in the 1st operation gestalt is explained. This disk unit is a disk unit which adopted the ZBR method mentioned above, and recording surfaces 120a, 120b, 120c, and 120d are divided into two or more zones, respectively. HDC180 assigns a spare truck as a spare field for each [ which was divided ] zone of every. At this time, a spare truck is assigned so that two or more spare trucks may not exist on the same cylinder. Furthermore, HDC180 controls a motor 140 and VCM170, and performs the record or playback of data to a desired sector. And further, when a desired sector is a defective sector, the alternate sector to the defective sector is arranged in a spare field, that is, rear sign processing is performed. A motor 140 rotates Disks 110a and 110b through the disk revolving shaft 130 in response to control of HDC180. Heads 150a, 150b, 150c, and 150d are supported by the actuator arm 160 so that recording surfaces 120a, 120b, 120c, and 120d may be countered, respectively, and they perform the record or playback of data to a desired sector. VCM170 moves Heads 150a, 150b, 150c, and 150d to the disk radial through an actuator arm 160 in response to control of HDC180.

[0051] Next, with reference to configuration method \*\*\*\*\* of the spare field by HDC180 mentioned above, and drawing 2, it explains to a detail more. Drawing 2 is the conceptual diagram of a disk cross section to show the arrangement location of the spare field in the 1st operation gestalt. As shown in drawing, recording surfaces 120a, 120b, 120c, and 120d are divided into two or more zones (a zone 1, a zone 2, --, Zone N are hereafter called from the outside of a disk, respectively), respectively. Drawing 2 shows the situation of arrangement of the spare field especially in the outermost zone 1 of two or more divided zones. A zone 1 consists of 24 trucks (trucks 1, 2, --, 24 are called similarly hereafter). In the recording surface of the 4th page, four trucks which exist in the equal distance from a core, respectively gather, one cylinder is formed, respectively, and 24 cylinders (cylinders 1, 2, --, 24 are called similarly hereafter) corresponding to 24 trucks are formed. 24 cylinders are classified into four cylinder groups (the cylinder groups 1, 2, 3, and 4 are called similarly hereafter) who consist of nine pieces, seven pieces, five pieces, and three cylinders, respectively.

[0052] A spare truck is assigned to one of four trucks which constitute the central cylinder, respectively in each cylinder group. In drawing 2, the slash section surrounded by the thick wire is set in the cylinder group 1, as the spare truck assigned to each cylinder group is shown and it is shown in drawing. A spare truck is assigned to the truck 5 on recording surface 120a, and it sets in the cylinder group 2 similarly. On the truck 13 on recording surface 120b, a spare truck is assigned to the truck 19 on recording surface 120c in the cylinder group 4 in the cylinder group 3 at the truck 23 on 120d of recording surfaces,



respectively.

[0053] Hereafter, by assigning a spare truck as mentioned above explains, comparing with the conventional technique which shows in drawing 8 that it can access from a defective sector to an alternate sector more in a short time. In addition, also in the conventional example shown in drawing 8, a zone 1 shall consist of 24 trucks (trucks 1, 2, --, 24 are hereafter called from the outside of a disk like this operation gestalt) like this operation gestalt.

[0054] For example, according to the conventional arrangement, when a defective sector arises on the truck 5 on 120d of recording surfaces in drawing 8, the alternate sector to the defective sector is arranged on the spare truck arranged on the truck 24 on the same recording surface, that is, rear sign processing is performed, for example. Therefore, access to an alternate sector from a defective sector will take the time amount concerning head seeking for 19 (= 24-5) trucks. On the other hand, according to this operation gestalt, in drawing 2, when a defective sector arises on the truck 5 on 120d of recording surfaces, the alternate sector to the defective sector is arranged in the spare truck arranged on the truck 5 on recording surface 120a. Therefore, access to an alternate sector from a defective sector will take the time amount concerning the change of a head. Usually, since the time amount which the change of a head takes is the time amount of extent equivalent to the head seek time for 1 thru/or 2 trucks, in access to an alternate sector, the time amount which is equivalent to head seeking for 17 thru/or 18 trucks compared with the conventional arrangement will be shortened.

[0055] Although especially the above-mentioned explanation described the case where a spare truck could be accessed only by head seeking from a defective sector, even if it is the case of others, the access time to an alternate sector is shortened similarly. For example, in the conventional configuration method shown in drawing 8, when a defective sector arises on the truck 10 on recording surface 120c, an alternate sector is arranged upwards at the spare truck arranged on the truck 24 on the same recording surface, and access to an alternate sector from a defective sector takes the time amount equivalent to head seeking for 14 trucks. On the other hand, when a defective sector arises on the truck 10 on recording surface 120c according to the configuration method by this operation gestalt shown in drawing 2, an alternate sector is arranged in the spare truck arranged on the truck 13 on recording surface 120b, and access to an alternate sector from a defective sector takes the time amount equivalent to head seeking for a total of 4 thru/or 5 trucks of the time amount equivalent to head seeking for three trucks, and the time amount which the change of a head takes. That is, according to the configuration method of this operation gestalt shown in drawing 2, in access to an alternate sector, the time amount equivalent to head seeking for 9 thru/or 10 trucks will be shortened compared with the conventional configuration method shown in drawing 8.

[0056] Thus, since a spare truck is arranged in the same location of each recording surface according to the configuration method of the conventional spare field shown in drawing 8, the spare truck which can be accessed by the shortest time amount from the defective sector of arbitration will exist on the same recording surface as a defective sector, and will be accessed by head seeking from a defective sector. On the other hand, according to the configuration method of the spare field of this operation gestalt, a spare truck Since it is arranged in a mutually different location of each recording surface, even if the same as that of the case where the arrangement consistency of the spare truck for every recording surface is the former for example The case where it can access by time amount with shorter accessing the spare truck which exists on a different recording surface from a defective sector arises by changing a head rather than it accesses the spare truck which exists on the same recording surface as a defective sector. Therefore, from the defective sector of arbitration, since it becomes possible to access a spare field by the same time amount as the former thru/or time amount shorter than before, the increment in the answering delay time amount of a disk unit can be suppressed.

[0057] In addition, since it is the disk unit which adopted the ZBR method, the recording surface is divided into two or more zones, but even if the disk unit of this operation gestalt is a case so that the whole disk unit which does not adopt a ZBR method, i.e., a recording surface, may be made into a single zone, it is the same approach and should just arrange a spare truck for two or more cylinder groups of every. Moreover, the number of cylinders which constitutes each zone becomes about hundreds in many

cases, with this operation gestalt, sets to 24 the number of cylinders contained in a zone 1 for description, and is not usually limited to this. Moreover, the location and number of spare trucks which are arranged for every cylinder group can also be set up according to the disk unit to be used. Furthermore, the number of the spare trucks arranged in each zone may also differ, respectively.

[0058] Moreover, you may divide not only into what also shows each cylinder group's magnitude divided to drawing 2 but into arbitration. In the recording surface of the disk which corrected, for example, has adopted the ZBR method like this operation gestalt, in each zone, since track recording density is as high as an inside truck and its consistency of record is close to a limitation, the probability for a defect to arise becomes high. Thus, when the probabilities for a defective sector to arise with the location on a recording surface differ, as shown in drawing 2, constituting from a smaller number of cylinders is more desirable [ a cylinder group with the higher probability for a defective sector to arise ]. By it, according to the rate of the spare truck included in a cylinder group which a defect produces, it becomes large comparatively, and access to the part and an alternate sector also serves as a short time. Therefore, while being able to use a spare truck more efficiently, it becomes possible to suppress more the increment in the answering delay time amount at the time of seeing by the whole disk unit. Moreover, when it, for example, stores the data which need to suppress the increment of answering delay time amount in image data, voice data, etc. as much as possible, by constituting from fewer cylinders, the rate of a spare truck becomes large and can access more the neighboring cylinder group who stores those data to an alternate sector in a short time.

[0059] Moreover, in drawing 2, in a zone 1, although four spare trucks are equally arranged to each of four recording surfaces, you may not arrange equally. however -- for example, when it becomes record of the data to a certain recording surface, or unreproducible, in order to secure an available spare truck by failure of a head etc., it is desirable for two or more recording surfaces to be alike, respectively, to receive, and to arrange an almost equal number of spare trucks.

[0060] Next, the actuation which chooses the spare truck for arranging an alternate sector in HDC180 is explained with reference to the flow chart shown in drawing 3.

[0061] an error produces HDC180 at the time of the record over a certain sector, or playback, recovery of the error is impossible and there is the need for rear sign processing -- judging (step S30) -- two or more cylinders which exist in the same zone as the zone where a defective sector exists first among the cylinders in which a spare truck exists, and an adjoining zone are elected as a cylinder candidate (step S31). A difference with the cylinder number of the cylinder in which a defective sector exists chooses from from the cylinder which has the smallest cylinder number among cylinder candidates (step S32). In the cylinder chosen in step S32, the recording surface in which a spare truck exists is chosen (step S33), and it checks whether the selected spare truck is usable (step S34). In step S34, when the selected spare truck is usable, rear sign processing is performed to the spare truck (step S35). The selected spare truck is already used by rear sign processing, and in step S34, when unusable, the cylinder in which the selected spare truck concerned exists is excepted from a cylinder candidate (step S36), and it repeats until the spare truck which can use return and the above actuation for step S32 again is determined.

[0062] By the above step, it can access by the shortest time amount from a defective sector, and an usable spare truck can be chosen.

[0063] In addition, although [ two or more cylinders which exist in the zone as the zone where a defective sector exists among the cylinders in which a spare truck exists where the cylinder candidate who elects in step S31 in the above-mentioned explanation is the same, and an adjoining zone ] elected as a cylinder candidate, how to choose a cylinder candidate cares about no cylinders in the disk unit in which for example, not only this but a spare truck exists also as a cylinder candidate.

[0064] In addition, in the 1st operation gestalt, although the disk unit is equipped with two disks and the recording surface of the 4th page, you may have one piece or three disks or more, and, similarly the number of recording surfaces is not restricted to the 4th page. The spare sector for arranging arrangement and the alternate sector of a spare field by the same approach also in these cases can be chosen.

[0065] Moreover, selection actuation of the spare truck for arranging the arrangement actuation thru/or

the alternate sector of a spare track by HDC180 explained above May be the gestalt which is beforehand included in ROM in HDC180 as a program, and is performed, and, respectively You may be the gestalt controlled by gestalt by which reads to RAM in HDC180 and \*\*\*\*\* activation is carried out through a record medium etc. from the exterior of HDC180, the computer connected to a disk unit by the equipment of the exterior of HDC180 in addition to this.

[0066] As mentioned above, according to the 1st operation gestalt, since a spare field can mainly be accessed from a defective sector using the change of a head by dividing two or more recording surfaces into two or more cylinder groups, and assigning one spare track to each of the cylinder group who divided, the head seek time which access to an alternate sector takes can be shortened more. Therefore, since it becomes possible to suppress the increment in answering delay time amount, consequently to reduce the capacity of a spare track further, it is possible to raise the use effectiveness of a disk.

[0067] (2nd operation gestalt) Drawing 4 is the block diagram showing the configuration of the disk unit concerning the 2nd operation gestalt. This disk unit is equipped with Disks 110a and 110b, the disk revolving shaft 130, a motor 140, Heads 150a, 150b, 150c, and 150d, an actuator arm 160, and VCM170 and HDC480 in drawing 4. Disk 110a has recording surfaces 120a and 120b, and disk 110b has recording surfaces 120c and 120d. In addition, in drawing 4, different points from drawing 1 are only the configuration method of the spare field by HDC480, and the configuration method of the alternate sector at the time of rear sign processing, and give the same reference mark to other configurations.

[0068] Hereafter, the actuation in the 2nd operation gestalt is explained. However, since it is only the configuration method of a spare field, and the configuration method of an alternate sector, a point which is different from the 1st operation gestalt in the actuation in this operation gestalt is omitted about other actuation, and is hereafter explained in order about the configuration method of the spare field in the 2nd operation gestalt, and the configuration method of the alternate sector at the time of rear sign processing.

[0069] Drawing 5 is a conceptual diagram to show the configuration method of the spare field in the 2nd operation gestalt. In addition, also in the 2nd operation gestalt, like the 1st operation gestalt, the disk unit shall have adopted the ZBR method, and especially by drawing 5, although only the outside zone 1 is shown most, it is taken as the thing of the zones divided into plurality which arranges a spare field similarly about other zones.

[0070] As the slash section of drawing 5 shows, the spare field a is arranged at recording surface 120a, similarly, the spare field c is arranged at recording surface 120c, and the spare field d is arranged for the spare field b at recording surface 120b at 120d of recording surfaces.

[0071] Drawing 6 is drawing showing typically the relation of arrangement of the spare field between four recording surfaces shown in drawing 5. Hereafter, with reference to drawing 5 and drawing 6, the configuration method of the spare sector in the 2nd operation gestalt is explained in detail.

[0072] First, about a certain track, number sector continuation is carried out and a spare field is prepared. Next, in order to enable it to access from this spare field more to the spare field on the recording surface of the others in the same cylinder for a short time, only A include angles which show the spare field of other recording surfaces in the same cylinder in the following formula arrange by shifting, respectively.

[0073] While changing a head, the include angle which a disk rotates is made into H times, the number of recording surfaces with which the spare sector is arranged at the cylinder concerned is set to M, and if the include angle to the core of a disk of the spare field prepared is made into S times, it will ask by  $A=360 L/M$  from positive integer L which fills  $360(L-1) < M(S+H) \leq 360L$ .

[0074] For example, H is set to A= 90 from an upper type by the case where set 80 and M to 4 and S is set to 1, and it arranges by shifting a spare sector 90 degrees, respectively.

[0075] As a result of carrying out similarly about other cylinders according to this approach, as shown in drawing 4 and drawing 5, in the cylinder of arbitration, the spare field arranged at recording surface 120b The spare field which is arranged to the spare field arranged at recording surface 120a in the location which the disk rotated 90 degrees, and is arranged at recording surface 120c The spare field which is arranged to the spare field arranged at recording surface 120b in the location which the disk

rotated 90 degrees, and is arranged at 120d of recording surfaces. It will be arranged in the location where the disk also rotated the spare field which is arranged to the spare field arranged at recording surface 120c in the location which the disk rotated 90 degrees, consequently is arranged at recording surface 120a 90 degrees to the spare field arranged at 120d of recording surfaces.

[0076] The effectiveness by arranging a spare field as mentioned above is explained. In the above-mentioned formula,  $L$  means the minimum disk rotational frequency taken [ after accessing without futility continuously to all the spare fields that exist in the same cylinder ] to return to the first spare field. And  $A$  means the include angle which divided equally total disk angle of rotation corresponding to the minimum disk engine speed by the number of spare fields. By shifting the spare field on each recording surface the include angle every  $A$  called for by doing in this way, and arranging it, it is possible to access all the spare fields in the same cylinder that there is no futility in a short time by starting from the spare field of the arbitration in a certain cylinder, and accessing in order other spare fields include-angle  $A$  Shifted and arranged.

[0077] It is the case where rear sign processing is performed to the defective sector which was collected continuously and produced, and only in the spare field which exists in one truck, such a configuration method is effective, especially when all alternate sectors will not be able to be arranged but an alternate sector will need to be arranged also to the spare field of other 1 or two or more recording surfaces. For example, when it has arranged without shifting an include angle [ as opposed to a disk core for two or more spare fields in the same cylinder ], in order to access the next spare field from a certain spare field, it must wait for a disk to rotate one time. It is possible to access the next spare field on the other hand, only by the time amount which a disk rotates  $A$  times, when two or more spare fields in the same cylinder are shifted an include angle every  $A$  and have been arranged like this operation gestalt. Furthermore, also when rear sign processing needs to be performed to continuation using all the spare fields in the same cylinder, whenever a disk rotates  $A$  times, it is possible to access all spare fields in order.

[0078] In addition, although the inside of each zone has arranged so that the number of spare sectors may increase, and the spare field is further arranged equally to four recording surfaces for the same reason as the 1st operation gestalt with this operation gestalt, it is not limited to these arrangement the same with having explained in the 1st operation gestalt.

[0079] Next, the actuation which chooses the alternate sector for performing rear sign processing in HDC480 is explained with reference to the flow chart shown in drawing 7 .

[0080] an error produces HDC480 at the time of the record over a certain sector, or playback, recovery of the error is impossible and there is the need for rear sign processing -- judging (step S70) -- it checks first whether the spare sector which exists on the same truck as a defective sector is usable (step S71). In step S71, when the spare sector on the same truck is usable, rear sign processing is performed to the spare sector concerned (step S74), and processing is ended.

[0081] It checks whether the spare sector which are other spare sectors to which it is already used by rear sign processing, and the spare sector on the same truck exists in the same cylinder as a defective sector in step S71 on the other hand when unusable, and exists in the location distant a defective sector and  $A$  include angles or more to a disk hand of cut and an opposite direction is usable (step S72). In addition, in step S72, it limits to the spare sector to which an include angle with a defective sector exists in the location distant  $A$  times or more to the disk hand of cut and the opposite direction for suppressing the time amount taken to access an alternate sector and to return from a defective sector to a part for disk 1 rotation. In step S72, when the spare sector concerned is usable, rear sign processing is performed to the spare sector concerned (step S74), and processing is ended.

[0082] On the other hand, when the spare sector in the same cylinder separated from the defective sector  $A$  include angles or more is unusable in step S72, it checks whether the spare sector in the same cylinder which exists in less than  $A$  include angles, and the spare sector which exists in a different cylinder from a defective sector are usable from other defective sectors (step S73). In step S73, if an usable spare sector is checked, terrier sign processing will be performed to the spare sector concerned (step S74), and processing will be ended. On the other hand, if an usable spare sector cannot be checked in step S73,

rear sign processing ends processing as activation being impossible.

[0083] An alternate sector is preferentially arranged by the above step to the spare field which can access and return from a defective sector between disk 1 rotations. Therefore, the increment in the answering delay time amount of the disk unit by access to an alternate sector is suppressed to the minimum. Moreover, the number of the spare sectors prepared for one truck since the spare sector of other recording surfaces in the same cylinder can be used only by the change of a head even when insufficient can be stopped with the spare sector to which the number of alternate sectors required for rear sign processing exists in one truck, and decline in disk use effectiveness is suppressed.

[0084] In addition, with this operation gestalt, although the spare sector is arranged on all trucks, when you do not need many capacity of a spare sector, the truck with which the spare sector is not arranged may exist. Moreover, although the spare sector arranged on one truck was summarized to one place and arranged, it may be divided and arranged in the truck. Moreover, although the case where the recording surface of a disk was especially equipped with two or more zones with a ZBR method was taken up, a ZBR method is not used, that is, the disk recording surface may consist of single zones.

[0085] Moreover, with this operation gestalt, although the spare field has been arranged in order of the list of the recording surface of a disk, it is not necessary to carry out in order of a list. Moreover, although the case where the number of the recording surfaces of a disk is four is treated, the 2nd page, the 3rd page, or the 5th page or more is sufficient. Moreover, although HDC480 performs arrangement of a spare truck, and arrangement of an alternate sector, these actuation may be gestalten which are beforehand included in ROM in HDC480 as a program, and are controlled, for example, and may be gestalten which are included in RAM in HDC480 through a record medium, and are controlled. Furthermore, you may be the gestalt controlled by the device of the exterior of HDC480, for example, the computer connected to a disk unit.

[0086] As mentioned above, since a spare field exists in all trucks, it is possible according to the 2nd operation gestalt, to access a spare field, without performing a change and head seeking of a head from the defective sector of arbitration. Therefore, it is possible to suppress the answering delay time amount of a disk unit by the time amount for disk 1 rotation. Furthermore, since the spare field arranged to two or more recording surfaces was detached more than the include angle that a disk rotates to the time amount which the change of a head takes and is arranged to it The need for the rear sign processing to two or more collected defective sectors arises. Only in the spare field which exists in one truck, also when an alternate sector cannot be arranged, it can access without futility one by one to two or more spare fields which exist on the recording surface from which it differs in the same cylinder, and an alternate sector can be arranged. Therefore, since it becomes possible to reduce the capacity of a spare truck at the same time the increment in answering delay time amount is suppressed, it is possible to raise the use effectiveness of a disk.

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[Translation done.]